The drawings have been amended to change Figures 37.1 and 37.2 to 37A and 37B. Also the reference to Figure 40 has been cancelled. The drawings have also been amended to add reference number 68 for the opening, 81 for a liner and 95 for a frame. Figure 4A has been amended to show that the tie is a bolt and sleeve.

The claims have been amended to remove reference to terms not found in the specification. The term "steel hollow section frames" has been changed to --ties--. The claims have also been amended to place same in conformance with U.S. practice.

Respectfully submitted,

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a frame component.

Brief Description of the Drawings

A preferred embodiment of the present invention will now be described by way of example only with reference to the accompanying drawings in which:

Figure 1 shows a reinforced steel formwork frame according to a first embodiment of the present invention;

Figure 2 shows a reinforced steel formwork frame according to a second embodiment of the present invention;

Figure 3 shows the formwork frame of Figure 1 with panel support ties according to a first embodiment;

Figure 4A shows a front view of a panel support tie shown in Figure 3;

Figure 4B shows a tie with integrally formed clips;

Figure 4C shows a different type of clip and its implementation for connecting steel rods together.

Figure 4D shows intersecting reinforcing bars held by clips

Figure 5 shows a perspective view of a formwork frame with panel ties according to a second embodiment of the present invention;

Figure 6 shows one support tie according to the second embodiment connected to two frame elements;

Figure 7 shows two panels according to a first embodiment;

Figure 8 shows one of the panels shown in Figure 7;

Figure 9 shows a panel according to a second embodiment of the present invention;

Figure 10 shows a liner for the panel shown in Figure 9;

Figure 11 shows a schematic diagram of similar panels connected together;

Figure 12 shows male and female couplings for connecting panels together;

Figure 13 shows a finished module according to a first embodiment of the present invention;

Figure 14 shows an end elevation of a number of vertically stacked modules;

Figure 15 shows a section of wall according to a

first embodiment;

Figure 16 shows a formwork frame for corner forms according to a first embodiment of the invention;

Figure 17 shows a formwork frame according to a third embodiment;

Figure 18 shows a formwork frame according to a fifth embodiment;

Figure 19 shows two panels connected together according to a second embodiment of the invention;

Figure 20 shows a support tie according to a third embodiment of the present invention;

Figure 21 shows a subframe assembly for a module according to a further embodiment of the present invention;

Figure 22 shows a top view of an alternative method for connecting corner modules together;

Figure 23 shows a screw in type support tie;

Figure 24 shows a corner tie according to a further embodiment of the present invention in top view;

Figure 25 shows a front view of a further embodiment of a corner tie according to the present invention;

~~Figure 26 shows a top view of a corner panel tie according to another embodiment of the present invention;~~ Figure 26A shows a top view of a corner panel tie according to the present invention Figure 26B shows a top

Figure 27 shows a top view of a corner tie according to a further embodiment of the present invention; 26B

Figure 28 shows an end view of a clip according to another embodiment of the present invention; Figure 27 shows a clip used with a corner tie of Figure 26B

Figure 29 shows a front sectional view of components of a support tie according to a further embodiment of the present invention;

Figure 30 shows a front view of a support tie according to another embodiment of the present invention;

Figure 31A shows a top view of a plate for a support tie according to one embodiment of the present invention;

Figure 31B shows a side view of a toothed tie for use with the plate shown in Figure 31A;

Figure 31C shows a toothed tie according to another embodiment of the present invention;

Figure 32 shows an end view of a strap tie according to the present invention;

Figure 33 shows an end view of a screw type tie according to the present invention;

Figure 34 shows a side view of the screw type tie shown in Figure 33;

Figure 35 shows an end view of another type of tie according to the present invention;

Figure 36 shows a side view of another type of tie according to the present invention;

Figure 37A shows a front view of a panel according to a further embodiment of the present invention;

Figure 37B shows an end view of the panel shown in Figure 37A;

Figures 38A, 38B, 38C and 38D show different rib structures for panels according to the present invention;

Figure 39 shows an alternative type of panel for a module according to the present invention; and

Figure 40 shows another embodiment of a panel for a module according to the present invention.

Description of the Preferred Embodiments

According to a preferred embodiment of the present invention formwork for building structures is simplified by making modules which can be connected together. A single module is made from a number of unique components.

As shown in Figure 1 a formwork frame 11 is constructed from a number of base elements which in this embodiment consist of two rectangular side wall frame elements 12, 13 and two rectangular end wall frame elements 14, 15. Each frame element is formed from a steel rod which is bent into a rectangular shape and welded at its end to form a continuous loop. A frame element could be formed by connecting together a number of straight steel rods to form a continuous loop. A steel reinforcement mesh 16 is provided and in this embodiment in a vertical orientation between the side wall frame elements 12 and 13 with three upright rods 17, 18, 19. The frame elements 12, 13, 14 and 15 are

assembled to form a box like frame structure with the reinforcing mesh 16 located with upright rods 17 and 19 in abutment with the end walls 14 and 15 and located approximately mid way between side framework elements 12, 13.

In the second embodiment of the invention shown in Figure 2 two reinforcement meshes 20, 21 are provided side by side and parallel to each other so that there is a small space between them. According to other embodiments of the invention additional reinforcement meshes may be provided and also reinforcements of a different configuration.

With the frame elements 12, 13, 14, 15 assembled as in Figure 1 they must be connected together to form a single box like frame 30. As shown in Figure 3 these components may be connected together using wire ~~but it is preferred to use panel support ties 31 which as shown in Figure 4 consist of rod elements which are arranged to lie co-terminus with the horizontal sections of each of the end wall frame elements 14, 15~~. The ends of the support ties 31 are provided with a threaded section 32, 33.

Clips 34 are provided to connect the support ties to the adjacent horizontal walls 35, 36, 37, 38 of the end frame elements 14, 15.

The clips 34 may be any suitably designed clip which is able to connect two rod-like components together.

The support ties 31 also include spacer elements 39, 40 which enable a separation to be achieved between side frame elements 12, 13 and end wall elements 14, 15.

Figure 4A also shows how vertical sections 41, 42 of the side frame elements 12, 13 can be connected to the clips 34. The clips 34 may include two socket elements having resilient finger elements which are able to grip the vertical sections 41, 42 and the horizontal sections 35, 36, 37, 38.

If it is desired to used continuous steel inside the modules the panel support ties 31 may be provided with

peripheral clips 43 formed thereon as shown in Figure 4B. The clips 43 are C-shaped and are adapted to clip onto continuous steel reinforcing and can also be used for steel mesh.

The clips 43 are arranged in a line along the length of the rod elements 31 and are arranged to be mutually perpendicular so that they can clip onto steel rods in mutually perpendicular planes.

It is also possible to have different sized clips at different locations along the length of the rods 31 so as to cover applications of steel of different thicknesses and located in non-uniform positions.

In the embodiment shown in Figure 4B the clips 43 can carry horizontal steel in combination with vertical steel.

According to another embodiment shown in Figure 4C, a double sided clip 44 may be provided to join horizontal steel 45 to vertical steel 46 in between the ties.

According to an alternative embodiment shown in Figure 5 and Figure 6 panel support ties 50 consist of round hollow plastic tubes which are also aligned horizontally co-terminus with the vertical sections of the end frame elements 14, 15. Each support tie 50 is connected to the corners of each side frame element 12, 13 by using either clips 51 or by tying the tubes 50 using wire. Alternatively adhesive tapes may be used or even fibreglass may be used to bind the tubes to the side frame elements 12, 13.

A steel bolt can be inserted through the tubes 50 to provide strength to the plastic tubes so as to hold panels together and also hold the frame elements together thus acting as spacers.

Figure 7 shows two panels 60, 61 which are fed onto the respective ends 62, 63 of support ties 31, 50. In Figure 7 only the end 63 of the support ties 31, 50 are shown.

An individual panel 60, 61 is shown in Figure 8 more

clearly and consists of a planar element having an inside major face 64 and an outside major face 65. The panel also has vertical edge faces 66 and horizontal edge faces 67 to form a substantially rectangular slab.

Each major face 64, 65 has four openings 68 provided in a symmetrical pattern close to respective corners of the panel 60, 61.

Each panel could be made from steel for reusable purposes, from plastic, plasterboard or even a cardboard version is possible as shown in Figures 9 and 10. The panel can also be formed with one of the major faces being recessed with respect to the edge faces so as to be able to receive a liner which can have a specifically configured major face so as to leave a textured effect or pattern on concrete with which it contacts.

Each of the edge faces 66, 67 is provided with coupling portions 69 which in Figure 8 are shown as holes. As shown in Figure 11 however the edge faces are preferably provided with dowels in one edge face and correspondingly shaped holes in the opposing edge face. This enables adjacent panels to be connected together with the dowels of one panel connecting with the holes of an adjacent panel 73.

On the horizontal edge faces 67 especially shaped dowel 74 may be provided as shown in Figure 12 which has a small vertical portion and its major portion running horizontally. The opposite edge face of the panel 72 is provided with a protruding cylindrical socket 75 which is adapted to receive the horizontal portion of the dowel 74.

In an alternative embodiment shown in Figures 9 and 10 the panels may be made of a sheet of cardboard 79 with holes 80 provided in a similar configuration to the previous embodiment. A cardboard liner 81 is provided having a matching major face 83, but with peripheral rectangular flaps 84.

The panel 79 is stapled to the major face 83 of the liner ~~82~~ 81 and the flaps 84 can be connected to flaps of

adjacent panels so that panels can be connected together.

It is preferred that the panel 79 is stapled to the liner ~~83~~ 81 and that flaps of adjacent panels are also stapled together.

Figure 13 also shows a finished module which has rectangular panels 91 connected to the ends of support ties 93 with nuts 94 screwed onto the ends of the ties 93 to fix the panels in position in a vertical orientation on either side of the inside frame 95. As shown the spacers 96 separate the panels 91 from ~~the frame 95~~ reinforcement 92.

Figure 13 shows how the ends of the reinforcement mesh 92 extend above, below and beyond the side walls of both the ~~frame 95 and the~~ panels 91.

In Figure 14 three finished modules 100, 101, 102 are stacked vertically and the reinforcement mesh of each module is shown as 103, 104 and 105. The lowermost limit of the reinforcement mesh 103 of module 100 extends almost as far as the top reinforcement mesh 105 of the bottom most unit 102, while the middle unit 101 has its reinforcement mesh 104 spaced from the other two reinforcement meshes 103, 105, but in parallel to both of these meshes, thus providing a continuous vertical reinforcement from one module to the next.

According to another variation the middle units 101 can be offset inwardly with respect to the upper and lower units 100, 102.

As shown in Figure 15 a wall may be assembled by having a series of modules connected together in a similar fashion to how bricks would positioned in a wall. It should be noted however that where it is necessary to construct a corner or an end to the wall, modules of different shapes are required, thus a half module 111 is required in the lowermost section of the wall at one end thereof and a corner module 112 is required at the opposite end of the wall in the second layer. Thus as shown in Figure 16 a corner module is made from frame elements which are connected together to form a right angled block frame with panel support ties 113 being

provided with wedged shaped key ways 170 and wedges are used to connect these panels together.

Figure 26B 27 shows another key way system for corner panels in which the key ways 171 are straight. In Figure 27, a key plate 172 is shown which is adapted to fit into the straight key ways 171 in combination with a threaded bolt or clip 173. Figure 28 shows one type of clip 173. This clip 173 actually clicks on and is U-shaped. The clip stops the panels or forms pushing out and separating vertically during concrete pouring.

The corner tie attachment described above is able to prevent movement in six different directions.

As shown in Figure 29 the support tie 174 has a ferrule 175, hold plate 176, tooth 177, rib 178, outer plate 179 and end screw 180.

The outer plate can be independent of this arrangement as shown in Figures 27 and 28.

The above type of support tie can be used along any part or place of the outside form.

A half version of these support ties can be produced for the bottom of the form when they are first arranged. In this embodiment the forms 182 rest on the support tie and the outer plates extend upwardly at each end as shown in Figure 30.

This bottom tie can be made in a single piece or can be adapted with a smaller screw. Alternatively it may be tied higher up where the initial form had its bottom ties.

It should be noted with the corner ties that the modules may be assembled on site instead of at the factory.

According to another embodiment of the invention ties can be produced with one thick side and the other side normal with an end screw. It should be noted that the hold plate is preferably rebated into the panel form.

If the support ties are moved out of the corner the rebate in the forms is filled with a tie having teeth 184 and corresponding opening 185 as shown in Figures 31a and

WHAT IS CLAIMED IS:

26. The modules and ties for constructing a formwork for a reinforced concrete structure as claimed in claim 33, wherein a construction of adjoining panels is formed by being joined together by fasteners.

27. The modules and ties for constructing a formwork for a reinforced concrete structure as claimed in claim 33, characterized by the hollow section steel with at least one layer of reinforcement being set and positioned between the two opposite frames of hollow section by being attached or welded to the spacing rods of the modules which subsequently support the steel reinforcement inside each the modules.

28. The modules and ties for constructing a formwork for a reinforced concrete structure as claimed in claim 27 such that the at least one layer of reinforcement is supported by steel hollow section frames opposite to each other in each module.

29. The modules and ties for constructing a formwork for a reinforced concrete structure as claimed in claim 33, wherein the ties are characterized by holding the modules erect and in position during pouring of concrete and when concrete has set molding covers are moved leaving the opposite hollow section frames et in the required concrete construction or pattern of adjoining modules or panels.

30. The modules and ties for constructing a formwork for a reinforced concrete structure as claimed in claim 29, characterized by the ties being set in a completed required concrete construction having faces exposed and attachments being made to opposite exposed faces of hollow section of the concrete construction.

31. A method of construction of modules and ties for constructing a formwork for a reinforced concrete structure as defined in claim 33, characterized by welding reinforcement to the spacing rods.

32. The construction of modules and ties for constructing a formwork for a reinforced concrete structure as claimed in claim 33, wherein they can be set in required position on construction site for concrete to be poured or set in position away from construction site and placed into required position as completed module or panel or construction or panels or modules.

33. A module and ties for constructing a formwork for a reinforced concrete structure, each module comprising

a rectilinear panel having opposed major surfaces, a continuous peripheral flange extending from one side face of the panels, providing means by which adjacent modules can be secured together to form a continuous formwork, a plurality of tie apertures in each of the major surfaces of the panels, each of said ties comprising an elongate bar adapted for engagement with apertures in the panels, means for spacing opposed panels in an erected formwork, means for securing the ties to the panels and means for securing and aligning horizontal and vertical reinforcing members between the formwork.